PREDICTION OF FRUIT QUALITY USING NEAR-INFRARED VIA NARX MODEL

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Dedicated, in thankful appreciation to my beloved husband, Rizman A. Majid for supporting, understanding loves and, encouragement. To my daughter and my sons, Nur Aina Batrisyia, Muhammad Ammar Uwais and Muhammad Amir Zubair thanks for being my spirit of inspiration. Dedication also to my parents, parents in law, brothers and sisters for their supporting all these years

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ABSTRACT

Nowadays, the awareness of health and safety among consumers has been increase. This scenario caused them become willing to pay more for high quality fruit products. However, it is not easy to grade fruits by using only our eyes. Therefore non-destructive fruits internal quality assessment technique is an area that both technology and market section concern about. The objectives of this project are to study about Near Infrared Spectroscopy (NIRS) as a fruit quality measurement method, to evaluate the use of NIRS for nondestructive measuring SSC of apples and to predict the best model of the measurement data by using Auto-Regressive with Exogenous Input (ARX) Model and Nonlinear Auto-Regressive with Exogenous Input (Nonlinear ARX) Model. The Near-Infrared (NIR) reflectance spectra and the soluble solids content (SSC) of apples data have been recorded before from an experiment. The impact of the orders or numbers of poles of the model has been investigated based on the performance (best fit) of the model. The ARX Model and Nonlinear ARX Model indicate excellent prediction performance of the model with the best fit value were 87.11% and 100% respectively.

ABSTRAK

Pada masa kini, kesedaran tentang kesihatan dan keselamatan dikalangan pengguna telah meningkat. Senario ini mengakibatkan para pengguna sanggup mengeluarkan kos yang tinggi atau membayar lebih untuk produk buah yang berkualiti tinggi. Walaubagaimanapun, pengredan buah tidak mudah dilakukan dengan hanya menggunakan mata kasar. Maka, teknik penilaian kualiti dalaman buah-buahan yang '*nondestructive*' adalah aspek yang amat diperhatikan oleh kedua-dua teknologi dan seksyen pasaran. Objektif projek ini adalah mengkaji tentang '*near infrared spectroscopy*' sebagai satu kaedah pengukuran kualiti buah – buahan, untuk menilai penggunaan '*near infrared spectroscopy*' bagi pengukuran '*soluble solid content' (SSC)* epal yang '*nondestructive*' dan menganggarkan model terbaik terhadap pengukuran data dengan menggunakan Model '*ARX* 'dan Model '*Nonlinear ARX'*. Data berkenaan *'Near-Infrared (NIR) reflectance spectra'* dan '*soluble solid content' (SSC)* epal telah direkodkan sebelum ini melalui satu eksperimen. Kesan peringkat sesuatu model atau bilangan kutub sesuatu model telah dikaji berdasarkan persembahan model tersebut. Model '*ARX'* dan Model *'Nonlinear ARX'* menunjukkan prestasi anggaran model yang terbaik dengan nilai *'best fit'* nya masing – masing adalah 87.11% dan 100%.

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LIST OF ABBREVIATIONS

NIR	-	Near Infrared
NIRS	-	Near Infrared Spectroscopy
SSC	-	Soluble Solid Content
ARX	-	Auto-Regressive with Exogenous Input
NARX	-	Nonlinear Auto-Regressive with Exogenous Input
ASD	-	Analytical Spectral Devices
PCR	-	Principal Component Regression
PCA	-	Principal Component Analysis
MLR	-	multiple linear regression
PLS	-	partial least squares
PC	-	Principal Components
SVD	-	singular value decomposition
FPE	-	final prediction error

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CHAPTER 1

INTRODUCTION

1.1 Background

According to general food guide pyramid in Figure 1.1, below, fruits and vegetables are locate at stage two which have to eat a lot or two to five serving from our meal. Therefore, fruits are important to human body because fruits can provide nutrients to us and also able to prevent some disease. This means that everybody have to concern about the quality of fruits.

In order to get best nutrients, high quality and safety standard are important issues that have to concern about. Generally fruits quality only focuses on the basis of size, colour, and surface defects. However, dry matter content, total soluble solids content, sugar content, juice acidity and firmness are important internal quality attributes of fruit products [1]. Most instrumental techniques to measure these properties are time consuming, destructive and costly, and require professional operations. Three major parameters determine the internal quality and the taste of apples are hardness, sugar content and titrateable acidity, which are still determined destructively [2]. Therefore, it is much needed for the development of a reliable, non – destructive method.

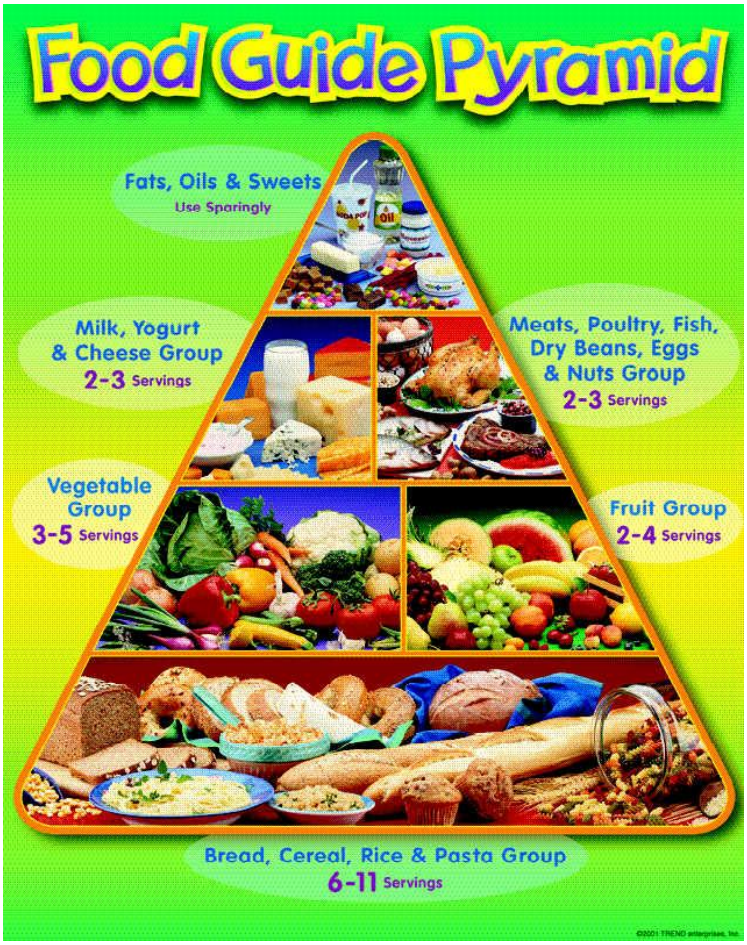

Figure 1.1 : Food guide pyramid

1.2 Problems statements

Nowadays, the awareness of health and safety among consumers has increase. This scenario caused them become willing to pay more for high quality fruit products. However, it is not easy to grade fruits using eyes. Any mistaken in grading process will contribute bad effects to consumers. Therefore, the Near infrared Spectroscopy (NIRS) is used to reveal all the internal quality attributes of fruits. Then for this study System Identification tool focusing to ARX (Auto-Regressive with Exogenous Input) Model and Nonlinear ARX (Nonlinear Auto-

Regressive with Exogenous Input) Model are applied to analyze the output spectra of NIRS.

1.3 Objectives of the project

The objectives of this project are listed below :

i. To study about Near Infrared Spectroscopy as a fruit quality measurement method.
ii. To evaluate the use of NIRS for nondestructive measuring SSC of apples
iii. To predict the best model of the measurement data by using Auto-Regressive with Exogenous Input (ARX) Model and Nonlinear Auto-Regressive with Exogenous Input (Nonlinear ARX) Model

1.4 Scope of the project

The scope of this study are :

i. Get the spectrum and SSC data from the fruit quality experiment.
ii. Using matlab software to analyze the spectrum and SSC data.
iii. Using ARX Model and Nonlinear ARX model in System Identification Tool to predict the best model of the measurement data.

1.5 Report outline

This report consists of six chapters were named as CHAPTER 1, CHAPTER 2, CHAPTER 3, CHAPTER 4, CHAPTER 5 and CHAPTER 6. Then, they followed by references and appendices.

In the first chapter, the background, problem statement, objectives, and scope of this project were stated out clearly.

Then, the literature reviews of this project which consist of NIRS and System Identification from previous researches and studies were written in chapter two.

Next, the procedure of the experiment to acquire spectra data and real SSC data that have done by Dr Herlina's Ph.D student, Mr Chia Kim Seng were recorded roughly in chapter three as a reference to this study .

In chapter four, the procedure of data processing using matlab program and System Identification Tool in the matlab software was recorded.

After that, the result and discussion about this project were presented in chapter five.

Lastly, conclusion and recommendation were presented in the chapter six.

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